REMARKS

The Office Action objected to the drawings under 27 CFR 1.83(a) because they fail to show a plasma excitation 106, plasma generator 110, and also Fig. 6A as described in the specification. The Office Action also rejected claims 1-4, 9-11 and 14 under 35 U.S.C 102(b) as anticipated over Ishizuka et al. (US patent 5,531,834). Further, claims 5-8, 12, 13, 15, 16, and 20 were rejected under 35 U.S.C. 103(a) as being unpatentable over Ishizuka et al. (US patent 5,531,834) in view of Qian et al. (US patent 6,447,636).

The Section 27 CFR 1.83(a) Rejection.

Applicant has amended the drawings in accordance with 27 CFR 1.83(a). Applicant has changed the reference to Fig. 6A to Fig. 7A in the specification. Withdrawal of the rejection is respectfully requested.

The Section 102(b) Rejections

The Office Action also rejected claims 1-4, 9-11 and 14 under 35 U.S.C 102(b) as anticipated over Ishizuka (US patent 5,531,834).

Ishizuka discloses an apparatus to perform semiconductor processing, comprising a process chamber 1, a plasma generator 15 for generating a plasma in the process chamber 1, and a flat coil electrode 13 coupled to the output of the plasma generator 15. The details of the flat coil electrode 13 of Ishizuka is described in Figs. 19-26, together with a few non-working electrodes in Figs. 27-30. The flat coil electrode of Ishizuka is flat, planar, and 2 dimensional. The flat coil electrode of Ishizuka is composed of multiple turns in the same plane. All turns of the flat coil of Ishizuka are different: the turns of the flat coil of Ishizuka

are successively smaller toward the center. Ishizuka's flat coil electrode ***is a coil which is in the form of a plane spiral extending parallel to wafer mount 2*** (col 6, lines 61-63) and ***may be of a one-turn type*** (col 11, lines 47-48).

However, Ishizuka did not show the invention as claimed: an apparatus to perform semiconductor processing, comprising a process chamber, a plasma generator for generating a plasma in the process chamber, and a helical ribbon electrode coupled to the output of the plasma generator. The helical ribbon electrode of the present invention is 3 dimensional, composed of multiple turns in different planes, and all the turns of the electrode are essentially similar. The difference between the present invention and Ishizuka's is the electrode. Ishizuka's flat coil electrode is a 2 dimensional inward spiral and the present invention ~~helical~~ spiral ribbon electrode is a a 3-dimensional cylindrical helix that forms many spiral turns in the direction perpendicular to the plane formed by the spiral turns, similar to a cylindrical spring with the coil in the form of a ribbon.

As discussed in Ishizuka's specification, Ishizuka's process chamber with the flat coil electrode is an improvement over the conventional CVD apparatus of parallel flat plate type. With the flat coil electrode, Ishizuka's chamber can generate an electric field due to the flatness of the flat coil electrode, and also can generate a magnetic field due to the inward spiral coil of the flat coil electrode. As a result, Ishizuka's chamber can generate both electric and magnetic energies (Col 3, lines 8-15).

Ishizuka also shows alternative electrodes which can be also employed suitably in Figs. 19-26 (col 13, lines 22-61), together with samples electrodes that do not work in Figs.

27-30 (col 14, lines 10-34). Of particular importance to the present invention is the disclosure of Ishizuka that the electrode of Fig. 28 (Fig. 28, sheet 15 of 25) does not work. The electrode of Fig. 28 is an one-turn ribbon electrode, similar to the present invention helical ribbon electrode with one turn.

Ishizuka thus requires that the flat coil electrode is flat, 2 dimensional, and large enough to generate an electric field. The one-turn ribbon electrode of Fig. 28 is much smaller than the one turn coil electrode of Fig. 20, and therefore does not work with Ishizuka's system.

In contrast, the helical ribbon electrode of the present invention is 3 dimensional and can be small. The one turn ribbon electrode of Ishizuka works in the current invention. This is an unexpected and innovative design over the prior art of Ishizuka. The details of the helical ribbon electrode is disclosed in the applicant's specification, paragraphs [0031] and [0032]:

> ***Figs. 2A-2C show more details of the helical ribbon 170. In Fig. 2A, an elongate conductive coil 172 insulated by a sheet of dielectric material 174 is wound to form a cylindrical helix. The two sides of the helix are then compressed into planes such that the coil 172 surfaces in each side lie flat and engage the adjacent side of the sheet of dielectric material 174.***
>
> ***The ribbon coil 172 may have about three to ten turns and may be made of any conductive, ductile metal, such as copper or aluminum. The coil 172 has a width that is substantially greater than its thickness. Preferably, the width is approximately one hundred times the thickness, although the ratio of width w to thickness t may conceivably range from 1 to 10000, depending on mechanical considerations and/or electrical parameters. Mechanical considerations affecting the optimum width/thickness ratio include, for example, build height and turns ratio. In one embodiment, the coil 172 has three turns, with the width of the coil 172 at about 40 millimeters and a thickness at about one millimeter.***

The advantages of the present invention apparatus with the helical ribbon electrode includes:

- A smaller electrode. The current helical ribbon electrode is of one turn and extends in the vertical direction, thus can be much smaller than that of Ishizuka. Ishizuka's flat coil electrode requires a large turn (Fig. 20), or a multiple turns (Figs. 19, 23) and discloses that a small turn does not work (Fig. 28). The smaller electrode will enable a smaller process chamber, smaller system foot print and lower cost.

- Higher power. The amount of power delivered to the electrode is proportional to the number of turns. By extending the helical ribbon electrode in the vertical direction, the current invention can have a significantly higher number of turns, leading to much higher power to that of Ishizuka's. Extending the number of turns in Ishizuka's flat coil electrode would also make the flat coil electrode much larger.

- Less electric field. Ishizuka's system is focus on providing a high electric field together with a magnetic field to generate a plasma. The electric field and the magnetic field in Ishizuka's system are coupled and cannot be separate. The current invention helical ribbon electrode has only one turn, therefore has less electric field. In the case of an electric field is desired, an separate bias power source can be installed. In various cases, an electric field forces the ion in the plasma to accelerate toward the electrode, thus create a difference in the top, bottom and the sidewall surfaces. Lower electric field tends to generate a more uniform reaction at the top, bottom and sidewall surfaces.

Applicant submits that Ishizuka cannot anticipate the present invention because that X Ishizuka does not disclose a helical ribbon electrode. Further, Ishizuka discloses that the

one-turn coil (Fig. 28), similar to the current invention helical ribbon electrode, will not work. Our work shows an unexpected and innovative result from Ishizuka that electrodes with one (or more turns in the third dimension) can generate a plasma for process. Withdrawal of the Section 102 rejections is respectfully requested.

The Section 103(a) Rejections

Claims 5-8, 12, 13, 15, 16, and 20 were rejected under 35 U.S.C. 103(a) as being unpatentable over Ishizuka et al. (US patent 5,531,834) in view of Qian et al. (US patent 6,447,636).

Qian discloses a semiconductor processing system comprising a chamber 100, a source power supply 105, and an antenna 102 coupled to the power supply 105. Qian's antenna 102 can be a flat, 2 dimensional spiral coil as shown in Fig. 4BB, or 3 dimensional cylindrical helical coil as shown in Figs. 4C, 4D and 4E, or 3 dimensional spiral coil as shown in Fig. 4A. However, Qian's antenna 102 is always a coil with a circular cross section as shown repeatedly in Figs. 1, 4A, 4B, 4C, 4D, and 4E.

X In contrast, the helical ribbon electrode of the present invention has a elongated cross section. The details of the helical ribbon electrode cross section is disclosed in the applicant's specification, paragraphs [0031] and [0032], disclosed that the helical ribbon electrode has a width much larger than the thickness, about 100 times to 10000 larger.

The advantages of the present invention apparatus with the helical ribbon electrode over Qian's includes:

- Higher power. The amount of power delivered to the electrode is proportional to the number of turns and the distance of the turn to the interior of the process chamber. By using a ribbon electrode that has the thickness to be hundreds of times less than the width, the turns of the helical ribbon electrode are extremely close to each other. As disclosed in paragraph 0032, the thickness of the helical ribbon electrode is about 1 mm thick, therefore each successive turn is only about 1 mm difference, therefore the deliver power is much greater than a circular cross section antenna.

- More uniform magnetic field. A circular cross section antenna will have circular magnetic field surrounding the antenna coil, thus the power distribution is concentrated underneath the antenna coil. In contrast, the helical ribbon electrode has a ribbon-like cross section, and this generates a flat magnetic field underneath the helical ribbon electrode, leading to a more uniform magnetic field.

Applicant submits that none of these references, singly or combination can render claims 5-8, 12, 13, 15, 16, and 20 obvious. Both Ishizuka and Qian do not show a helical ribbon electrode as disclosed in the current invention. Since this element is missing, and since this element has many significant advantages over the prior arts of Ishizuka and Qian. neither Ishizuka nor Qian can render the claims obvious. Withdrawal of the rejection is requested.

In summary, Applicant submits all claims of the present application are patentable over the prior art. Allowance of all claims is respectfully requested.

CONCLUSION

In view of the foregoing, applicants believe all claims now pending in this application are in condition for allowance.

Attached is a marked-up version of the changes made by the current amendment. The attached page is captioned with "VERSION WITH MARKINGS TO SHOW CHANGES MADE."

If for any reason the Examiner believes that a telephone conference would in any way expedite prosecution of the subject application, the Examiner is invited to telephone the undersigned at 510-299-7249 (cell) or (510) 438-4881 (office) or (510) 656-4420 (home).

Respectfully submitted,

Tue Nguyen

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to:

Assistant Commissioner for Patents
Washington, D.C. 20231

On January 25, 2003
By: ______________________
Tue Nguyen

VERSIONS WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

Page 19, line 21 (or in the patent application publication 2003/0008500: column 5, paragraph 0052, line 2): Please replace the reference to Fig. 6A to a reference to Fig. 7A.

A chuck 608 movably supports a substrate 610. In Fig. [6A] <u>7A</u>, the chuck 608 and the substrate 610 are elevated and ready for deposition. The substrate 610 is positioned inside the chamber. Suitable processing gas is introduced into the chamber through the inlets 604, and a pulsed plasma controller 605 is periodically turned on in accordance with a process activation switch to drive the desired process.

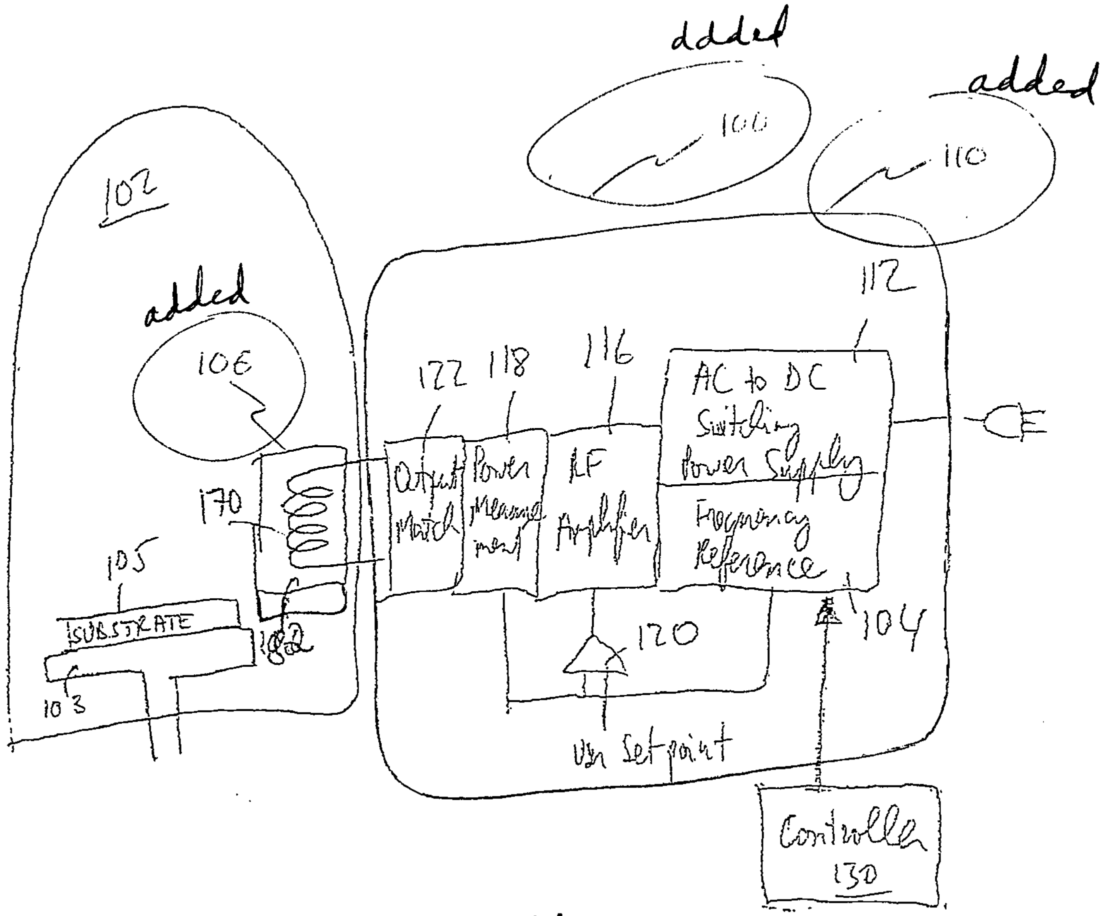


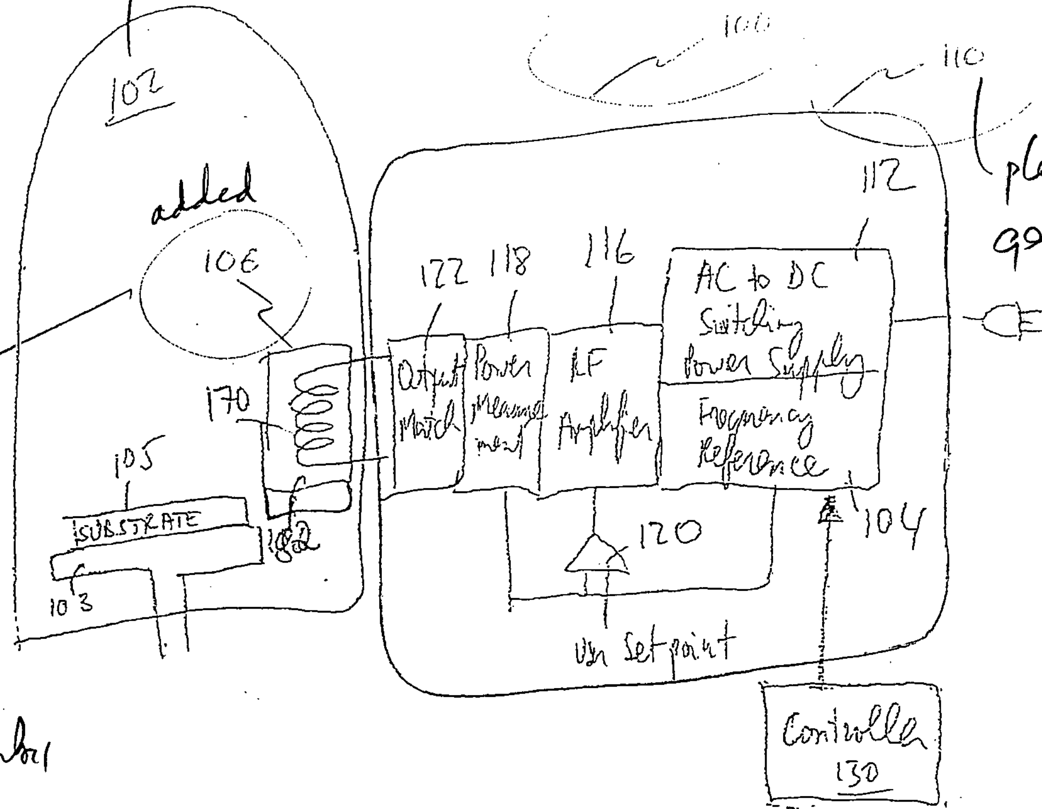
FIG. 1A

Version with markings to show changes made

process chamber

added

added



plasma generator

helical electrode external to the process chamber

FIG. 1A

Version with markings to show changes made